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10/564,486	01/13/2006	Hyo-Kun Son	3449-0567PUS1	9185
2292 7590 09/04/2007 BIRCH STEWART KOLASCH & BIRCH PO BOX 747 FALLS CHURCH, VA 22040-0747			EXAMINER MIYOSHI, JESSE Y	
			ART UNIT 2809	PAPER NUMBER
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

mailroom@bskb.com

Office Action Summary

Application No.

10/564,486

Applicant(s)

SON, HYO-KUN

Examiner

Jesse Y. Miyoshi

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 13 January 2006.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-25 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-25 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 13 January 2006 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date 1/13/06 and 4/16/07.
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____.
- 5) ☐ Notice of Informal Patent Application
- 6) ☐ Other: _____.

DETAILED ACTION

Specification

1. The disclosure is objected to because of the following informalities: line 36 of page 7, the phrase "about-20-time higher reverse" should be replaced with "about 20-times higher reverse".

Appropriate correction is required.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

3. Regarding the claims having the limitation of a plurality of pits or hexagonal pits such as claims 2, 3, 8, 12 and 13, the specification does not adequately describe their formation except on page 7, lines 18-22. The Examiner takes the position that the hexagonal pits are created solely due to the "dislocations and defects resulting from the doped n-type GaN layer and defects resulting from the super lattice structure."
4. Claims 14 and 15 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. Equation 1 provided on page 7 of the specification states "2%(1st InGa_N layer

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$\leq \text{In}/\text{InGa} \leq 3\%(2^{\text{nd}} \text{ InGaN layer})$ " and does not imply the claimed limitations of either claim 14 or 15 which are that each layer of the multi-layer has In content of 3% or less or 2% or less, respectively. The equation merely states that 2% of the first InGaN layer is less than or equal to some percentage of In in InGa which is also less than 3% of the second InGaN layer and is not indicative of the actual percentage required in the first and second layers of the InGaN/InGaN multi-layer structure.

5. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

6. Claims 14 and 15 recites the limitation "In" and claim 6 does not state that there is In in the multi-layer. There is insufficient antecedent basis for this limitation in the claim. Additionally, for purposed of examination, the Examiner will view claims 14 and 15 as depending from claim 7. Claims 14 and 15 are interpreted as requiring the multi-layer to be composed of InGaN where the In content is less than 3% and 2% of each layer in the multi-layer, respectively.

Claim Rejections - 35 USC § 102

7. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

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8. Claims 1, 4, 6, 7, 9 and 16 are rejected under 35 U.S.C. 102(b) as being anticipated by Okumura (U.S. 6,370,176).

Re claim 1: Okumura teaches a light emitting device comprising: a substrate (sapphire substrate 1; column 6, lines 12-13 and figure 1); a gallium nitride layer provided above the substrate (GaN buffer layer 2; column 6, lines 13-14 and figure 1); an N-type gallium nitride layer (n-type GaN layer 3; column 6, line 14 and figure 1) provided above the gallium nitride layer; at least one $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{In}_y\text{Ga}_{1-y}\text{N}$ multi-layer ($0 < x, y < 1$) provided above the N-type gallium nitride layer, x being different from y (multi-quantum well (MQW) structure 7 composed of $\text{In}_{0.15}\text{Ga}_{0.85}\text{N}$ and $\text{In}_{0.03}\text{Ga}_{0.97}\text{N}$; column 6, lines 14-19 and figure 1); and a P-type gallium nitride layer provided above the $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{In}_y\text{Ga}_{1-y}\text{N}$ multi-layer (p-type GaN layer 9; column 6, line 20 and figure 1).

Re claim 4: Okumura teaches the device according to claim 1, wherein each layer of the $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{In}_y\text{Ga}_{1-y}\text{N}$ multi-layer has a thickness of 1~3000Å (three $\text{In}_{0.15}\text{Ga}_{0.85}\text{N}$ quantum well layers having thickness of 5nm each and two $\text{In}_{0.03}\text{Ga}_{0.97}\text{N}$ barrier layers each having thickness of 5nm each; column 8, lines 26-29).

Re claim 6: Okumura teaches a light emitting device comprising: a first gallium nitride layer (GaN layer 29; column 11, line 15 and figure 2); a second gallium nitride layer (GaN layer 22; column 11, lines 6-7 and figure 2); an active layer formed between the first gallium nitride layer and the second gallium nitride layer (active layer 27; column 11, lines 11-12 and figure 2); and a multi-layer formed between the second gallium nitride layer and the active layer to intercept an applied electrostatic discharge (MQW structure 23; column 11, line 7 and figure 2; since the structure is provided, it is

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inherent that the structure could perform the function of intercepting an applied electrostatic discharge).

Re claim 7: Okumura teaches the device according to claim 6, wherein the multi-layer is an $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{In}_y\text{Ga}_{1-y}\text{N}$ multi-layer ($0 < x, y < 1$) (MQW structure 23 is composed of $\text{In}_{0.2}\text{Ga}_{0.8}\text{N}$ and $\text{In}_{0.03}\text{Ga}_{0.97}\text{N}$ layers; column 11, lines 7-9).

Re claim 9: Okumura teaches the device according to claim 6, wherein the multi-layer has a plurality of layers of different In content, the plurality of layers being alternately stacked in the multi-layer (MQW structure 23 is composed of $\text{In}_{0.2}\text{Ga}_{0.8}\text{N}$ and $\text{In}_{0.03}\text{Ga}_{0.97}\text{N}$ layers; column 11, lines 7-9).

Re claim 16: Okumura teaches the device according to claim 6, wherein the second gallium nitride layer is an N-type layer (n-type GaN layer 22; column 11, lines 6-7 and figure 2).

Claim Rejections - 35 USC § 103

9. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

10. Claims 2 and 3 are rejected under 35 U.S.C. 103(a) as being unpatentable over Okumura as applied to claim 1 above, and further in view of Uchida ("Journal of Electronic Material: *Photoluminescence characteristics and pit formation of InGaN/GaN*

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Quantum-Well Structures Grown on Sapphire Substrates by Low-Pressure Metalorganic Vapor Phase Epitaxy").

Re claim 2 and 3: the teachings of Okumura have been discussed above.

Okumura fails to teach the device wherein the $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{In}_y\text{Ga}_{1-y}\text{N}$ multi-layer has a plurality of pits formed thereon; and wherein the number of the pits is 50 or less per area of $5\mu\text{m} \times 5\mu\text{m}$ (which is roughly $2 \times 10^8/\text{cm}^2$).

Uchida teaches InGaN-based quantum-well (QW) structures, where a single QW surface had pits with an average diameter of 20nm and pit density was estimated to be on the order of $6 \times 10^7/\text{cm}^2$.

Because it is well-known for pits to form on InGaN-based QW structures, it is obvious that the light emitting device as taught by Okumura having a InGaN-based MQW structure would have a plurality of pits formed thereon with an average density of $2 \times 10^8/\text{cm}^2$ or less and by understanding the pit-formation mechanism, high-quality InGaN-based QW structures may be developed (paragraph 3 of introduction of Uchida).

11. Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Okumura as applied to claim 1 above, and further in view of Kim et al. ("Mat. Res. Soc. Symp. Proc. Vol. 722 Materials Research Society: *Structural and Optical Properties of InGaN/GaN Multi-Quantum Well Structures with Different Well Widths*").

Re claim 5: the teachings of Okumura have been discussed above.

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Okumura fails to teach the device wherein the $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{In}_y\text{Ga}_{1-y}\text{N}$ multi-layer has a photoluminescence characteristic of a yellow band intensity/N-doped GaN intensity ratio of 0.4 or below.

Kim et al. teaches an InGaN/GaN MQW structure having various well widths each width having an effect on the photoluminescence (PL) characteristics. Kim et al. teaches the intensity ratio of the yellow band to the peak intensity varied according to the well thickness and for a well width of 6nm, the yellow band to peak intensity ratio was 0.4 (page K7.12.5 and figure 5 Inset).

It would be obvious to vary the well width, as taught by Kim et al., of the $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{In}_y\text{Ga}_{1-y}\text{N}$ multi-layer as taught by Okumura to obtain a yellow band to peak intensity ratio to be 0.4 or below. By keeping the well width below 6nm, the yellow band to peak intensity would therefore be below 0.4, allowing the device to have the benefit of a higher emission intensity (abstract of Kim et al. page K7.12.1).

12. Claims 8, 12 and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Okumura as applied to claim 6 above, and further in view of Uchida ("Journal of Electronic Material: *Photoluminescence characteristics and pit formation of InGaN/GaN Quantum-Well Structures Grown on Sapphire Substrates by Low-Pressure Metalorganic Vapor Phase Epitaxy*").

The teachings of Okumura have been discussed above.

Okumura fails to teach the device wherein the multi-layer has a plurality of pits formed thereon; wherein the multi-layer has a plurality of pits formed thereon, the

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number of the pits being 50 or less per area of $5\mu\text{m} \times 5\mu\text{m}$; and wherein the multi-layer has a plurality of hexagonal pits formed thereon.

Re claim 8: Uchida teaches the device wherein the multi-layer has a plurality of pits formed thereon (InGaN/GaN QW hexagonally shaped pits in the QW structures; paragraph 1 of introduction by Uchida).

Re claim 12: the device wherein the multi-layer has a plurality of pits formed thereon, the number of the pits being 50 or less per area of $5\mu\text{m} \times 5\mu\text{m}$ (which is roughly $2 \times 10^8/\text{cm}^2$) (pit density is estimated to be on the order of $6 \times 10^7/\text{cm}^2$; paragraph 3 of results and discussion).

Re claim 13: the device wherein the multi-layer has a plurality of hexagonal pits formed thereon (InGaN/GaN QW hexagonally shaped pits in the QW structures; paragraph 1 of introduction).

It would have been obvious to one of ordinary skill in the art at the time of the invention that the teachings of the hexagonal pits and their density would have been present in the multi-layer taught by Okumura. The device as taught by Okumura would have the benefit of a high quality InGaN-based QW structure by knowing the effects of their formation as taught by Uchida (abstract and paragraph 3 of introduction).

13. Claims 10, 11, 14 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Okumura as applied to claim 6 above, and further in view of Kozaki et al. (U.S. 6,711,191; hereinafter "Kozaki").

The teachings of Okumura have been discussed above.

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Okumura fails to teach the multi-layer device wherein the alternating layers are of different growth temperatures.

Re claim 10: Kozaki teaches the device wherein the multi-layer has a plurality of layers of different growth temperatures, the plurality of layers being alternately stacked in the multi-layer (at 750 to 800°C a well layer of $\text{In}_{0.3}\text{Ga}_{0.7}\text{N}$ was grown and then a barrier layer made of $\text{In}_{0.1}\text{Ga}_{0.9}\text{N}$ was grown at 850 to 950°C; column 34, lines 28-34 of Kozaki).

It would have been obvious to one of ordinary skill in the art at the time of the invention to have the multi-layer be made of layers grown at different temperatures as taught by Kozaki to be incorporated into the device as taught by Okumura which will allow the device to have the benefit of enhanced output power and reliability of the laser device (column 5, lines 14-15 of Kozaki).

Re claim 11: Kozaki teaches the device wherein the multi-layer has two layers of different growth temperatures, the two layers being formed at 800°C and 900°C, respectively (at 750 to 800°C a well layer of $\text{In}_{0.3}\text{Ga}_{0.7}\text{N}$ was grown and then a barrier layer made of $\text{In}_{0.1}\text{Ga}_{0.9}\text{N}$ was grown at 850 to 950°C; column 34, lines 28-34 of Kozaki).

Re claim 14: the device wherein each layer of the multi-layer has In content of 3% or less with respect to Ga and In content (Okumura teaches having a single layer of the multi-layer being made of $\text{In}_{0.03}\text{Ga}_{0.97}\text{N}$ having 3% In content compared to Ga, however the alternating layer of the multi-layer is $\text{In}_{0.2}\text{Ga}_{0.8}\text{N}$ having 20% In content compared to Ga; by applying the teachings inherent in Kozaki where InGa_N grown at higher temperatures have less In content, see column 34, lines 28-34 of Kozaki, the

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multi-layer taught by Okumura could be made at higher temperatures yielding both alternating layers having In content less than 3%).

Re claim 15: the device wherein each layer of the multi-layer has In content of 2% or less with respect to Ga and In content (similar to the teachings disclosed regarding claim 14, the multi-layers of InGaN taught by Okumura could be made to have In content below 2% by raising the temperature at which the layers are grown).

14. Claims 17-25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Okumura and further in view of Kozaki.

Re claim 17: Okumura teaches a method for manufacturing a light emitting device, the method comprising the steps of: forming a buffer layer above a substrate (GaN buffer layer 2 grown on sapphire substrate 1; column 8, lines 8-11 and figure 1); forming an N-type gallium nitride layer above the buffer layer (n-type GaN layer 3 is grown; column 8, lines 12-13 and figure 1); forming a multi-layer above the N-type gallium nitride layer (layer 4 of MQW structure is formed of layers $\text{In}_{0.2}\text{Ga}_{0.8}\text{N}$ and $\text{In}_{0.03}\text{Ga}_{0.97}\text{N}$; column 10, lines 27-39); forming an active layer above the multi-layer (active layer 7 is then grown; column 8, lines 29-30 and figure 1); and forming a P-type gallium nitride layer above the active layer (p-type GaN layer 9 is grown; column 8, line 35 and figure 1).

Okumura fails to teach the multi-layer including layers of different growth temperatures.

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Kozaki teaches forming a multi-layer including layers of different growth temperatures (at 750 to 800°C a well layer of $\text{In}_{0.3}\text{Ga}_{0.7}\text{N}$ was grown and then a barrier layer made of $\text{In}_{0.1}\text{Ga}_{0.9}\text{N}$ was grown at 850 to 950°C; column 34, lines 28-34).

It would have been obvious to one of ordinary skill in the art at the time of the invention to use the technique of growing alternating layers of a multi-layer portion of a device using different temperatures for each alternating layer as taught by Kozaki into the method of forming the device as taught by Okumura resulting in a light emitting device having a multi-layer, where the multi-layer is made by using different temperatures for growing each layer and will allow the device to have the benefit of enhanced output power and reliability of the laser device (column 5, lines 14-15 of Kozaki).

Re claim 18: Okumura teaches the method wherein the multi-layer has a plurality of InGaN layers of different In content, the InGaN layers being alternately stacked in the multi-layer (layer 4 of MQW structure is formed of layers $\text{In}_{0.2}\text{Ga}_{0.8}\text{N}$ and $\text{In}_{0.03}\text{Ga}_{0.97}\text{N}$; column 10, lines 27-39 of Okumura).

Re claim 19: Kozaki teaches the method wherein the multi-layer has a plurality of layers of different growth temperatures formed thereon, the different growth temperatures being a high temperature and a low temperature, respectively (at 750 to 800°C a well layer of $\text{In}_{0.3}\text{Ga}_{0.7}\text{N}$ was grown and then a barrier layer made of $\text{In}_{0.1}\text{Ga}_{0.9}\text{N}$ was grown at 850 to 950°C; column 34, lines 28-34 of Kozaki).

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Re claim 20: Kozaki teaches the method wherein the high temperature is 900°C (a barrier layer made of $\text{In}_{0.1}\text{Ga}_{0.9}\text{N}$ was grown at 850 to 950°C; column 34, lines 28-34 of Kozaki).

Re claim 21: Kozaki teaches the method wherein the low temperature is 800°C (at 750 to 800°C a well layer of $\text{In}_{0.3}\text{Ga}_{0.7}\text{N}$ was grown; column 34, lines 28-34 of Kozaki).

Re claim 22: Okumura teaches the method wherein the multi-layer is formed using TMGa, TMI, ammonium, and nitrogen (InGaN layers are grown using trimethyl gallium (TMG), ammonia (NH_3) and trimethyl Indium (TMI); column 8, lines 26-30 of Okumura; it is well-known to use Nitrogen gas during the fabrication process because Nitrogen is commonly used as a purge and carrier gases, and so it is inherent that the prior art would have used Nitrogen during intermediate steps of fabricating the multi-layer).

Re claim 23: Okumura teaches the method wherein each layer of the multi-layer has a thickness of 1~3000Å (thickness of InGaN layers are 5nm each; column 8, lines 26-27 of Okumura).

Re claim 24: Kozaki teaches the method further comprising the step of forming a slow-growth gallium nitride layer above the buffer layer (after growing the buffer layer at 1050°C, an underlying layer 103 made of undoped GaN was grown; column 36, lines 59-61 of Kozaki).

Re claim 25: Kozaki teaches the method further comprising the step of forming an undoped gallium nitride layer above the slow-growth gallium nitride layer (layer 107

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made of undoped GaN was grown at 1050°C; column 37, lines 21-23 and figure 16 of Kozaki).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jesse Y. Miyoshi whose telephone number is (571) 270-1629. The examiner can normally be reached on M-F 7:30AM-5:00PM EST. Alternating Fridays off.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kimberly Nguyen can be reached on (571) 272-2402. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.


Klesha L. Rose
Primary Examiner
Aug. 28, 2007

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